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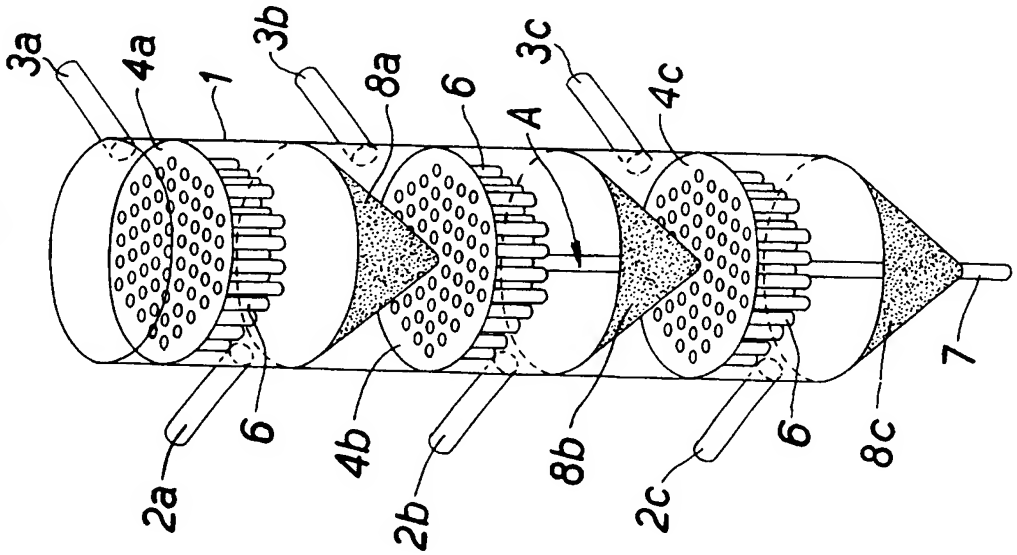
(54) Filtration module.

(57) Filtration module wherein entrained solids are removed from a carrier fluid via filtration with (ceramic) candles. The filter design comprises a plurality layers or "tiers" of filters (6) and a tiered conical ash sluicing system (8) to concentrate and centralize ash sluicing. Solids discharge from tiered layers avoids re-entrainment of solids in gas flow in lower layers. Solids re-entrainment reduces the effectiveness of the additional lower surface area.

FIG.1



EP 0 572 063 A1

The invention relates to an apparatus including a number of separate vertically tiered filter assemblies for filtering out particulate material of a predetermined minimum size from a carrier fluid produced by e.g. (partial) combustion processes.

In particular, the invention relates to a high pressure high temperature filter unit design such as applied in coal gasification where entrained solids such as ash are removed from produced synthesis gas via filtration with ceramic candles at temperatures of about 100-800 °C and such as applied in oil gasification for removal of dry soot via filtration with ceramic candles at pressures till about 60 bar.

A known method of separating particulate material from flue gases produced by combustion and other such processes utilizes porous filter elements which may comprise a multiplicity of filter tubes supported in parallel relationship to one another by a common support plate or tube sheet as it is often called. Flue gases are generally quite hot, for example 150 °C, and are typically at atmospheric pressure. Under these conditions, the filter tubes are typically made of polyester, acrylic or glass. For pressurized fluid bed combustion the resultant gases can be as high as 900 °C at gas pressures from 5 to 15 times atmospheric pressure, in which case the filter tubes are constructed of porous ceramic or rigid sintered porous stainless steel. The particles to be captured by the different tubes vary in size from 0.2 microns to 20 microns and can weigh in total up to 10 parts per thousand of the weight of gas or more. When the deposit of dust on a filter element increases to 2 or 3 mm, the pressure drop steadily rises and the elements must be cleaned by shaking the tubes, by reversing gas flow or by means of applying high pressure gas pulses through the filter tubes.

A general difficulty in the design of any industrial filter assembly comprising a multiplicity of small individual filter tubes of the type recited above is to properly and conveniently assemble such elements in a single vessel. Such a vessel may be required to contain many hundreds of tubes and the particulate laden fluid (which may be a gas or a liquid) must enter the vessel in such a way as to be well distributed around the individual filter tubes. Moreover, each filter tube must be cleaned in any one of the ways mentioned above or in any other suitable way and the particulate material cleaned from these tubes must be collected and eventually removed from the vessel. The filtered fluid must then be ducted from the vessel at a convenient location.

All of these requirements impose many mechanical, thermal and aerodynamic constraints in the design and construction of the overall filtering apparatus.

Heretofore, a typical apparatus utilizing filtering tubes included a main vessel containing a single plate or tube sheet for supporting the filter tubes in a vertically depending manner. This particular type of apparatus has a number of drawbacks. In the first place, the only way that its filter area can be enlarged is by extending its tube sheet diameter in order to support more filter tubes. This quickly leads to a practical mechanical limit.

Because the tube sheet is generally supported only at its circumferential edge, it tends to sag at its center as a result of increasing weight, or it must be made sufficiently thick to prevent sagging which eventually becomes economically prohibitive. Even advanced alloy tube sheets do not overcome this problem at high temperatures. To solve this problem by providing center supports is also impractical because of problems associated with the differential expansion and contraction due to the relatively high temperatures. Even if this problem could be solved, assuming it would be economically justifiable to do so, there are other drawbacks associated with increasing the size of the tube sheet to accommodate a larger number of filter tubes. For example, as the tube sheet increases in size, the overall apparatus becomes squat in shape and eventually unsuitable for barge, rail or road transportation. Also, as the tube sheet increases in size, the containment vessel itself must be enlarged not only in diameter but also in thickness in order to contain and support the tube sheet and internal pressure. Obviously, providing a sufficiently large vessel can be quite expensive and, again, economically prohibitive.

While it may be possible to increase filtering capacity of an apparatus of the type just described by increasing the lengths of its filtering tubes, this is, of course, selflimiting also. Moreover, some rather attractive new advanced ceramic filter tubes have become available but cannot be made any longer than about 1.5 meters.

Thus, in order to expand the filtering capacity of the apparatus of the type described above, utilizing these particular filter tubes would require extending the tube sheet diameter and therefore result in the problems just discussed.

Further, it is already known to apply an apparatus for filtering out particulate material of a predetermined minimum size from flue gases produced by combustion or other such processes in a relatively hot and even pressurized environment, said apparatus comprising a main containment vessel defining an interior compartment having inlet means through which the particulate laden flue gases (or other such carrier fluid being filtered) can pass in order to enter the compartment. The vessel also includes separate

outlet means through which the carrier fluid, once filtered, can pass in order to leave the compartment. A plurality of filter assemblies are disposed within the vessel compartment and are supported in spaced apart relationship with one another and with the containment vessel itself by means of a single support tube also disposed within the vessel compartment. This tube which preferably extends in a vertical direction serves as a sole means for supporting the filter assemblies, and, at the same time, cooperates with these assemblies and the vessel's outlet means in order to serve as a discharge pipe for directing the filtered fluid out of the vessel through its outlet means.

However, the known devices still have technical scaling-up problems and problem areas with respect to large scale configuration.

Further, there is a risk of solids re-entrainment which reduces the effectiveness of the apparatus.

The present invention solves these problems and provides a solids discharge from tiered layers which avoids re-entrainment of solids in fluid flow in lower layers.

The invention therefore provides an apparatus for filtering out particulate material of a predetermined minimum size from a carrier fluid produced by (partial) combustion processes, said apparatus comprising:

a) an elongated vessel provided with a plurality of inlet means through which a particulate carrier fluid can pass and a plurality of separate outlet means through which said carrier fluid, once filtered, can pass;

b) an outlet means through which the particulates can pass to leave the vessel;

c) a plurality of vertically spaced filter assemblies; wherein the said filter assemblies are carried by tubesheets mounted to the vessel in such a manner that compartments are formed; and

comprising a tiered conical particulate sluicing system to concentrate and centralize the particulate sluicing.

The invention will now be described by way of example in more detail by reference to the accompanying drawing in which the fig. 1 represents a conceptual design for a 3-tiered filtration module of the invention; and fig. 2 represents a detail of fig. 1.

Referring now to fig. 1 an elongated vessel 1 comprising a plurality of "dirty" gas inlets (2a, 2b, 2c) through which the solids laden fluid passes and "clean" gas outlets (3a, 3b, 3c) through which the filtered fluids can pass, has been shown.

The vessel 1 contains, in any way suitable for the purpose, a plurality of tubesheets (4a, 4b, 4c) each supporting, in any way suitable for the purpose, a plurality of filter tubes 6. In this manner a compartmented vessel is formed.

Advantageously, ceramic filter candles are applied as filter tubes 6. In another advantageous embodiment of the invention sintered metal candles are applied as filter candles.

The vessel 1 is provided at its bottom with a solids discharge 7 connected to any suitable means for further processing of the solids (not shown for reasons of clarity).

Further, the vessel 1 comprises a tiered conical solids sluicing system to concentrate and actualize solids sluicing.

This system comprises a plurality of sluicing cones (8a, 8b) attached to a tubesheet (4b, 4c) and the wall of the vessel 1 and each mechanically connected by a substantially vertical sluicing duct A discharging into the cone below.

The lowest cone (8c) is connected to the solids discharge 7.

Fig. 2 shows in more detail the arrangement of tubesheet 4c, connecting duct A from next higher tier and sluicing cone 8b.

In fig. 1 only 3 tubesheets, 3 sluicing cones, 3 gas inlets and 3 gas outlets have been shown for reasons of clarity. However, it will be appreciated that any number of tubesheets, sluicing cones, gas inlets and gas outlets, suitable for the purpose can be applied.

Further, any suitable number, shape and material of the filters can be used.

The invention will be illustrated by way of example only by reference to the following design:

Design Basis	
Filter Media	ceramic candles
Filter Dimensions	6 cm outer diameter x 1.5 meters length
Maximum Packing Density	1 candle per 0.125 m^2 tubesheet area
Clean Plenum Height	0.5 meters
Sluicing Cone Angle	15 degrees (half angle, 30 degrees full angle)

Double Tier	
Number Elements	912
Tubesheet outer diameter	2.9 meters
Total vessel height	16.9 meters

Triple Tier	
Number Elements	912
Tubesheet outer diameter	2.4 meters
Total vessel height	22.3 meters

Vessel Wall Thickness	
Pressure	26 bar
Temperature	about 120 °C
Vessel Material	carbon steel

Double Tier	
Vessel wall thickness	100 mm
Vessel Weight	131 tons

Triple Tier	
Vessel wall thickness	83 mm
Vessel Weight	116 tons

Various modifications of the present invention will become apparent to those skilled in the art from the foregoing description. Such modifications are intended to fall within the scope of the appended claims.

Claims

1. An apparatus for filtering out particulate material of a predetermined minimum size from a carrier fluid produced by (partial) combustion processes, said apparatus comprising:
   a) an elongated vessel provided with a plurality of inlet means through which a particulate carrier fluid can pass and a plurality of separate outlet means through which said carrier fluid, once filtered, can pass;
   b) an outlet means through which the particulates can pass to leave the vessel;
   c) a plurality of vertically spaced filter assemblies; wherein the said filter assemblies are carried by tubesheets mounted to the vessel in such a manner that compartments are formed; and
   comprising a tiered conical particulate sluicing system to concentrate and centralize the particulate sluicing.

2. The apparatus as claimed in claim 1, wherein said tiered conical particulate sluicing system comprises a plurality of substantially vertical sluicing ducts, a plurality of sluicing cones, each sluicing duct connected to the next higher cone and discharging into the cone below, and each sluicing cone connected to the tubesheet below.

3. The apparatus as claimed in claims 1 or 2, wherein the filter assemblies comprise filter candles.

4. The apparatus as claimed in claim 3, wherein the filter candles are ceramic candles.

5. The apparatus as claimed in claim 3, wherein the filter candles are sintered metal candles.

6. The apparatus as claimed in any one of claims 1-5, comprising 3 tubesheets comprising filter assemblies, and 3 sluicing cones.

FIG.1

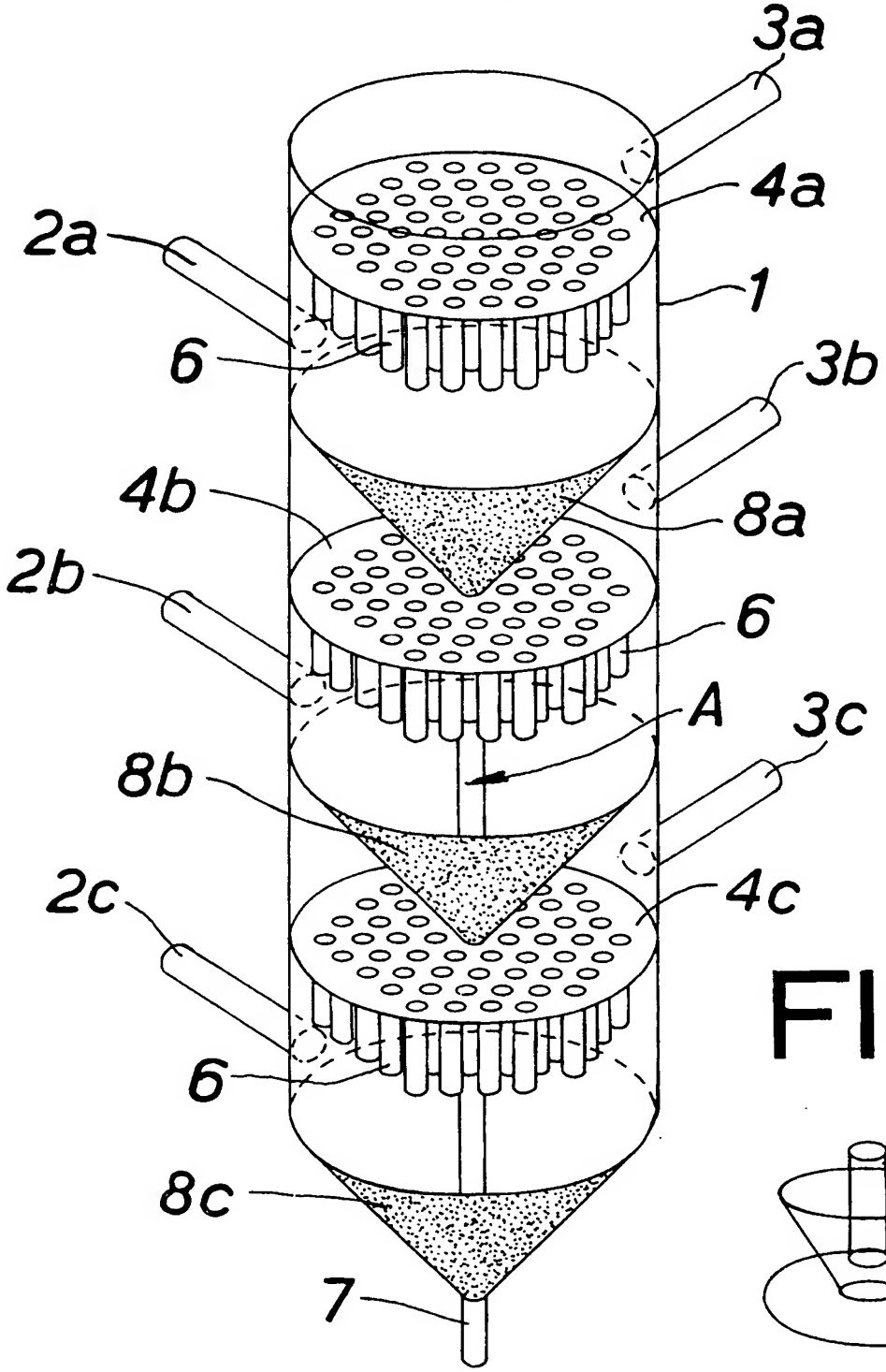
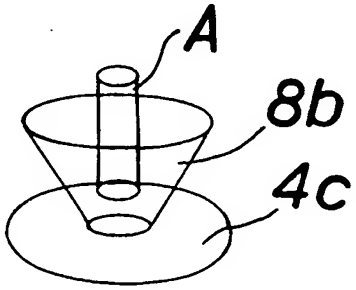


FIG.2



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EUROPEAN SEARCH REPORT

Application Number EP 93 20 1384

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	GB-A-2 155 354 (DEUTSCHE BABCOCK WERKE AG) * claims 1-9; figure 1 *	1,3,4,6	B01D46/24 F23J15/00
A	EP-A-0 078 661 (JOHNSON) * page 8, line 21 - page 10, line 14; claim 1; figures 1-5 *	1,2,5	
A	EP-A-0 482 396 (WESTINGHOUSE ELECTRIC CORPORATION) * claims 1-8; figure 1 *	1-6	
A	EP-A-0 129 053 (ELECTRIC POWER RESEARCH INSTITUTE)	1-6	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

B01D
F23J

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	23 AUGUST 1993	CUBAS ALCARAZ J.L.

CATEGORY OF CITED DOCUMENTS

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